

$4\ell + \text{Met}$ signal parametrisation

Abdualazem Fadol

July 1, 2019

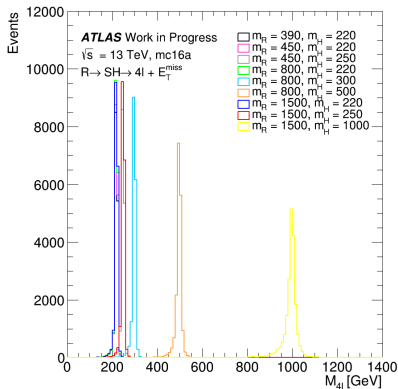


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- Since the combinations between R and H peak around the mass of the H boson;



- The mass points from (220-1000) GeV are modelled using a Crystal ball plus Gaussian Pdf.

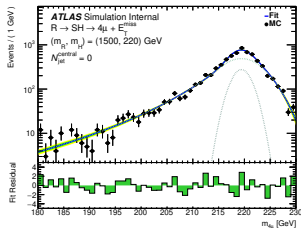
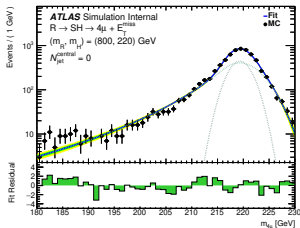
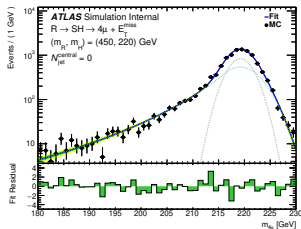
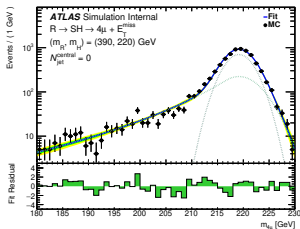
- The Crystal ball, CB, plus Gaussian, G, Pdf has the following form:

$$f(m_{4\ell}) = f_{CB} \cdot \text{CB}(m_{4\ell}; \mu, \sigma_{CB}, \alpha_{CB}, n_{CB}) + (1 - f_{CB}) \cdot \text{G}(m_{4\ell}; \mu, \sigma_G)$$

- σ_C and σ_G represent the invariant mass resolution;
 - μ is the mean value fixed to same parameter for both Pdf;
 - n_C and α_C model the shape and position of the non-Gaussian tail;
 - Where n_C is the slop of the tail and α_C measures how far from the peak the distribution become non-Gaussian;
 - f_C is the relative normalisation of the Pdf.
- The fit is performed after the 4-lepton cut and the following cuts:
- $N_{\text{jet}}^{\text{central}} = 0$, $p_T^{4\ell} > 20 \text{ GeV}$ and $\text{Metsig} > 2.0$
 - $N_{\text{jet}}^{\text{central}} \geq 1$ and $\text{Metsig} > 2.5$

Zero central jet category

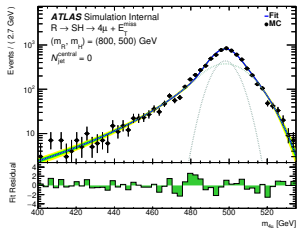
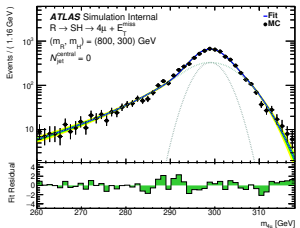
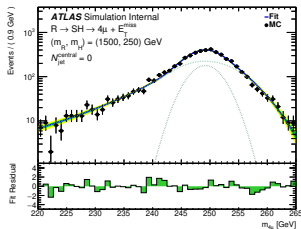
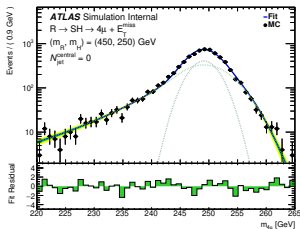
4μ -channel



Zero central jet category

4μ -channel

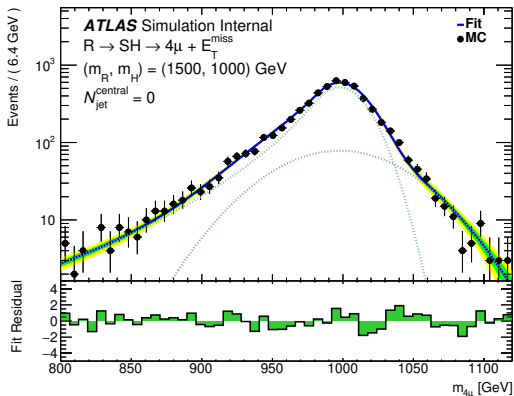
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Zero central jet category

4μ -channel

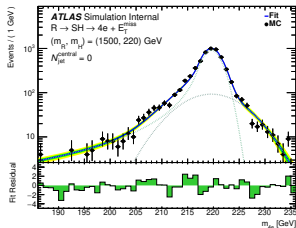
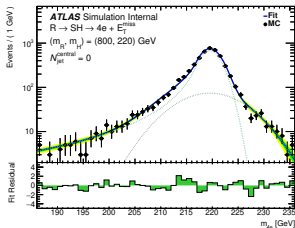
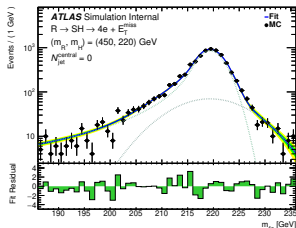
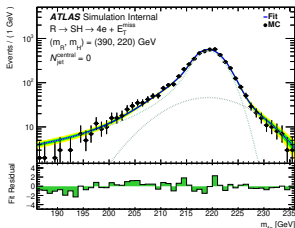
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Zero central jet category

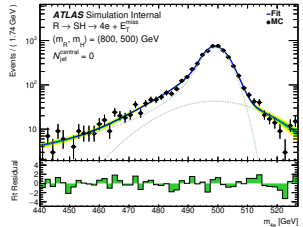
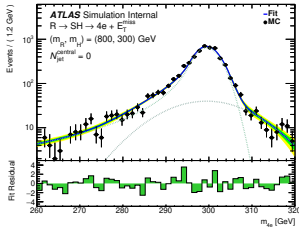
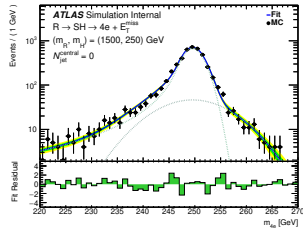
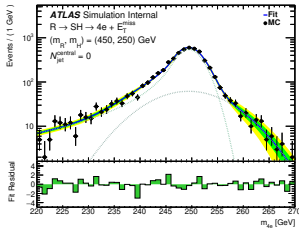
4e-channel

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Zero central jet category

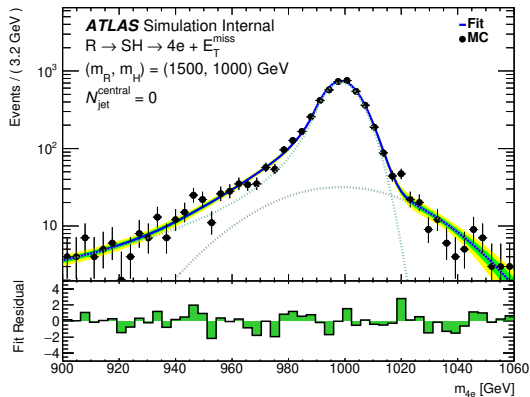
4e-channel



Zero central jet category

4e-channel

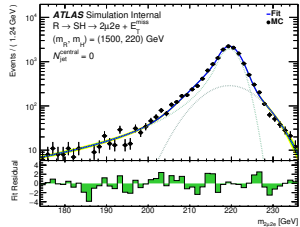
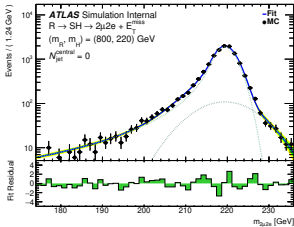
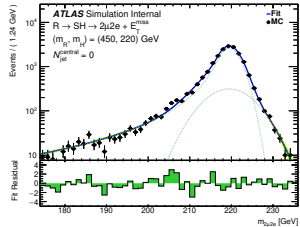
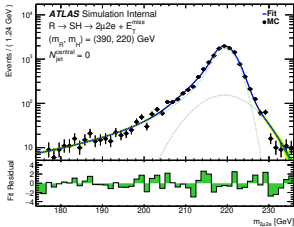
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Zero central jet category

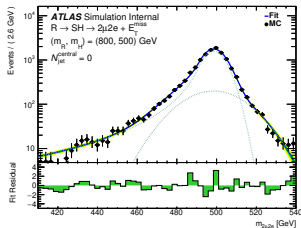
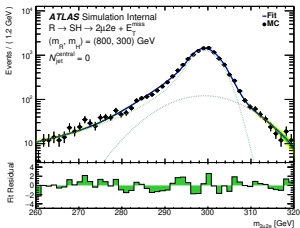
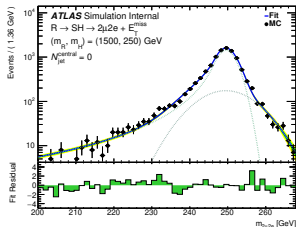
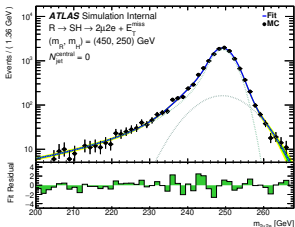
$2\mu 2e$ -channel

10



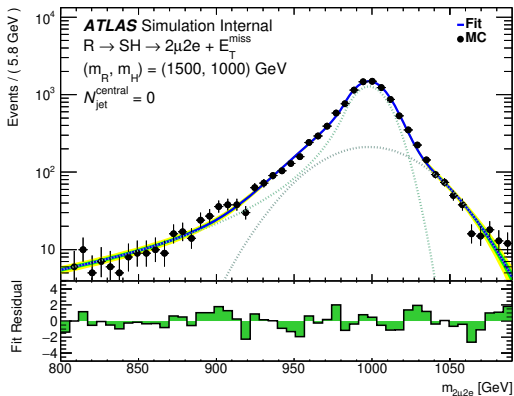
Zero central jet category

$2\mu 2e$ -channel



Zero central jet category

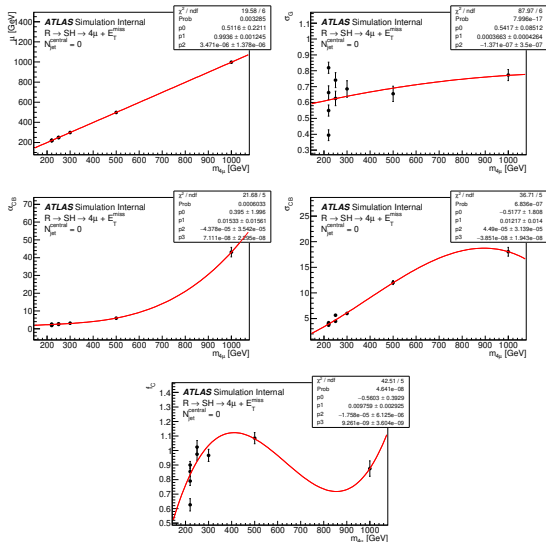
$2\mu 2e$ -channel



Interpolation of μ , f_C , σ_G , σ_C and α_C parameters

4 μ -channel

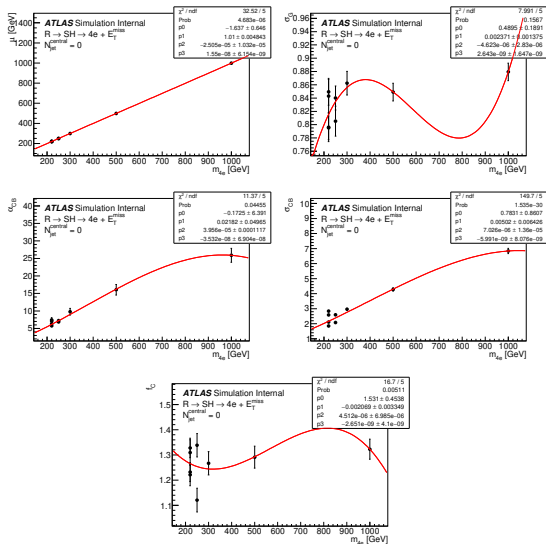
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Interpolation of μ , f_C , σ_G , σ_C and α_C parameters

4e-channel

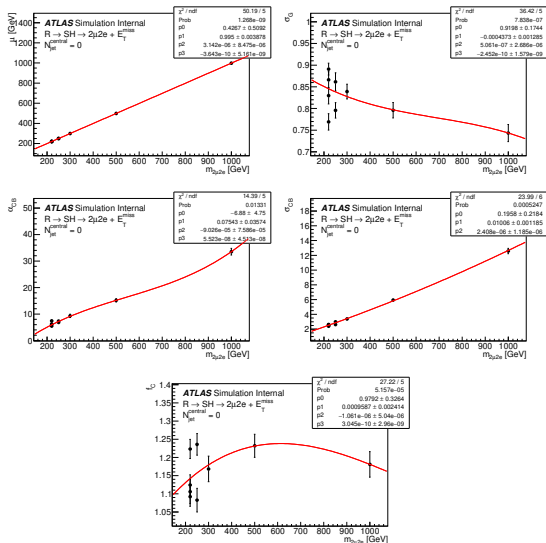
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Interpolation of μ , f_C , σ_G , σ_C and α_C parameters

2 μ 2e-channel

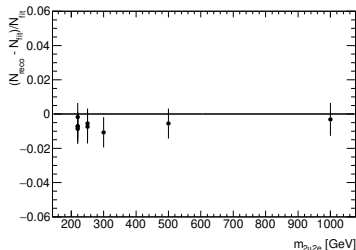
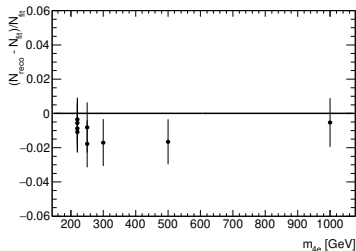
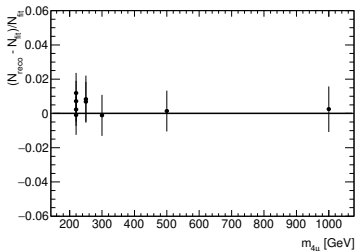
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Study the bias induced by the signal extraction

Zero central jet category

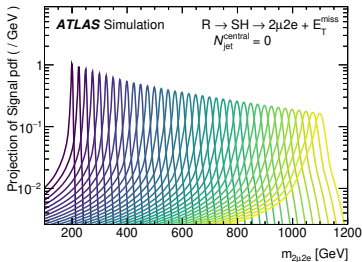
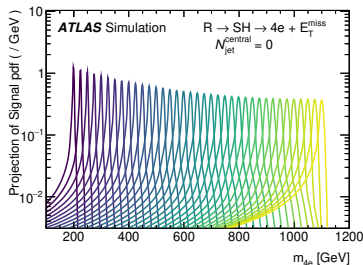
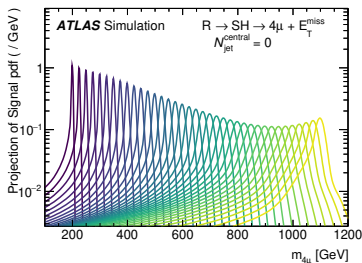
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The final signal shapes, interpolated from the polynomial fit parameters

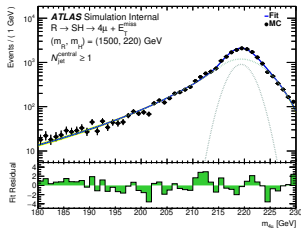
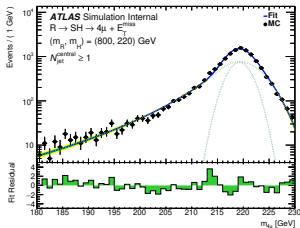
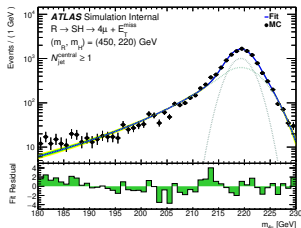
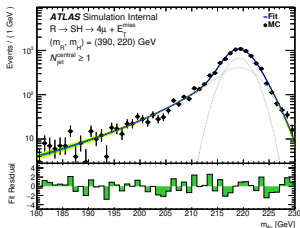
Zero central jet category

17



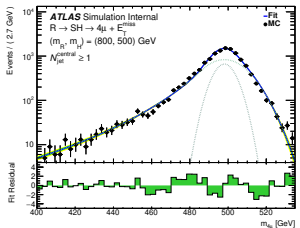
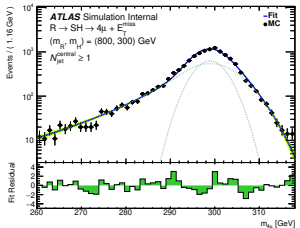
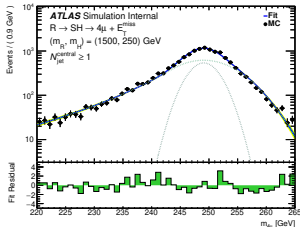
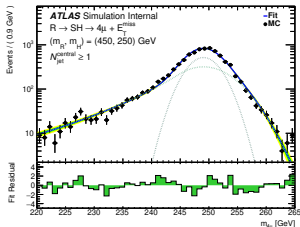
At least one central jet category

4μ -channel



At least one central jet category

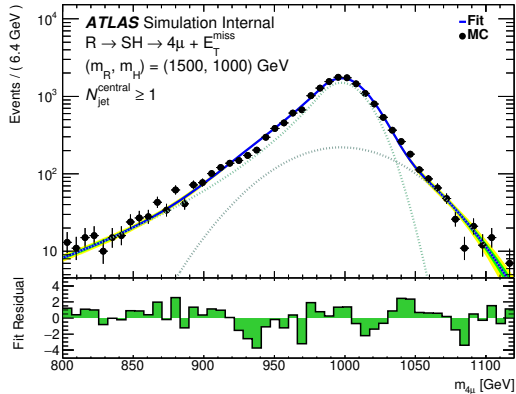
4μ -channel



At least one central jet category

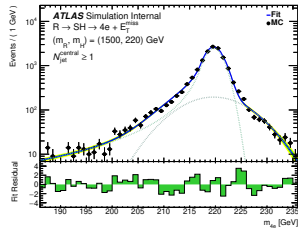
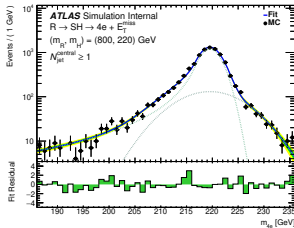
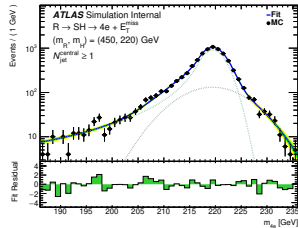
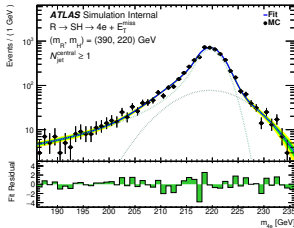
4μ -channel

20



At least one central jet category

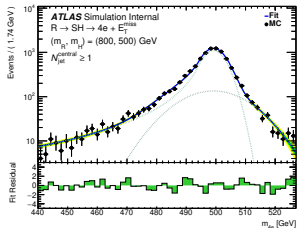
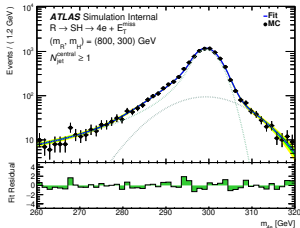
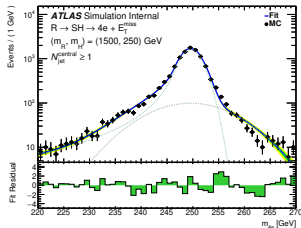
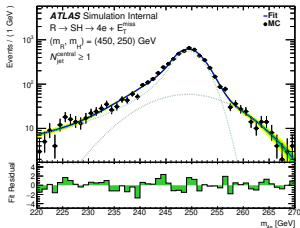
4e-channel



At least one central jet category

4e-channel

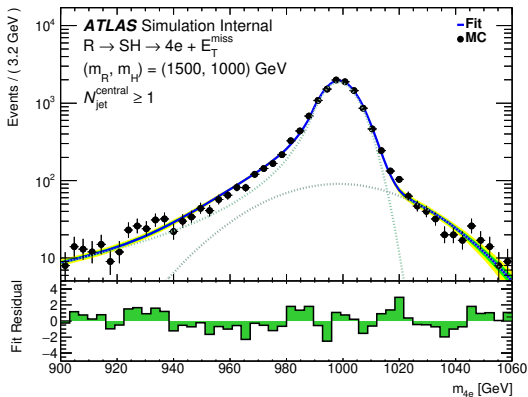
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At least one central jet category

4e-channel

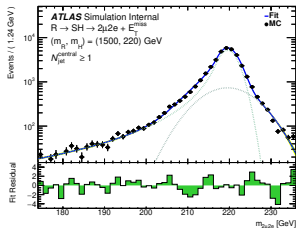
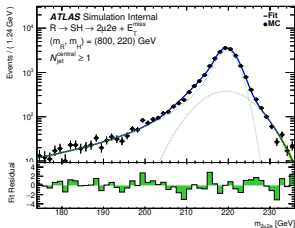
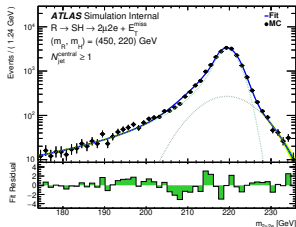
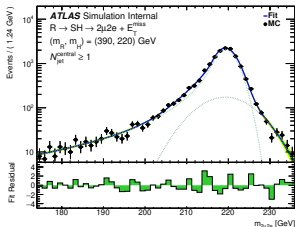
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At least one central jet category

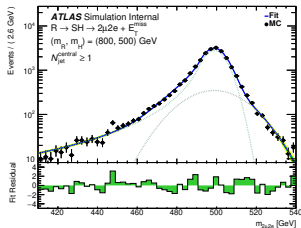
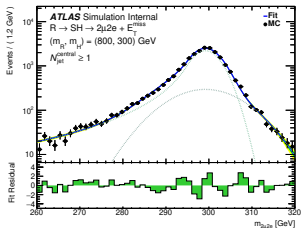
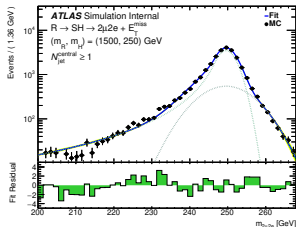
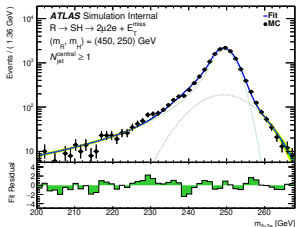
$2\mu 2e$ -channel

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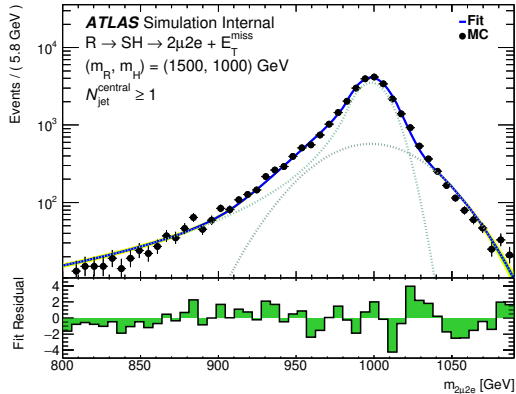
At least one central jet category

$2\mu 2e$ -channel



At least one central jet category

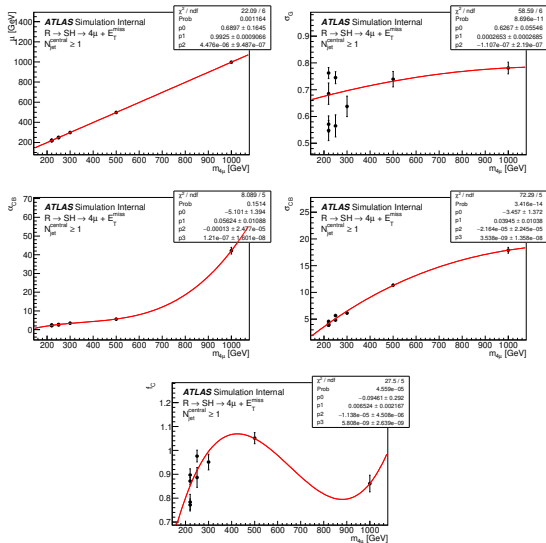
$2\mu 2e$ -channel



Interpolation of μ , f_C , σ_G , σ_C and α_C parameters

4 μ -channel

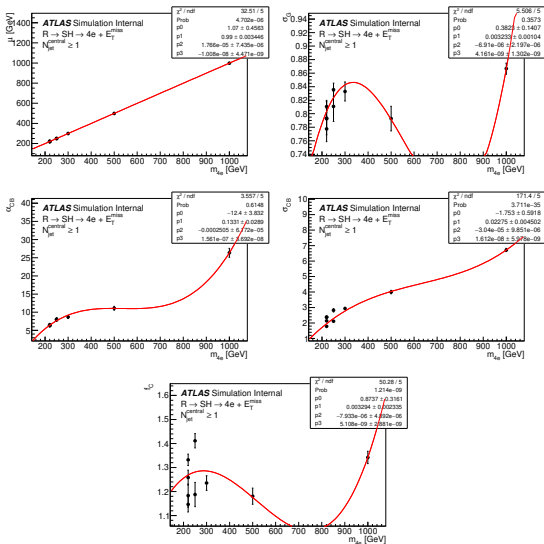
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Interpolation of μ , f_C , σ_G , σ_C and α_C parameters

4e-channel

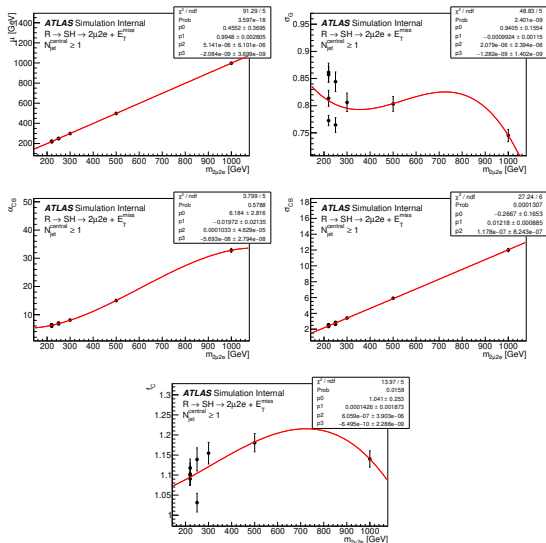
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Interpolation of μ , f_C , σ_G , σ_C and α_C parameters

$2\mu 2e$ -channel

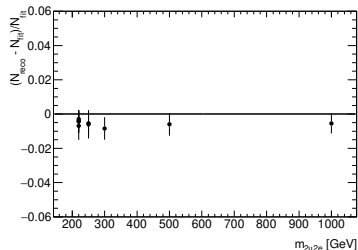
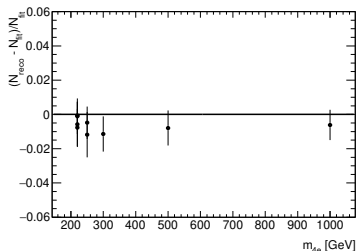
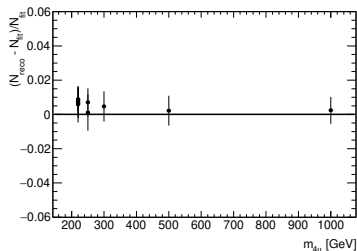
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Study the bias induced by the signal extraction

At least one central jet category

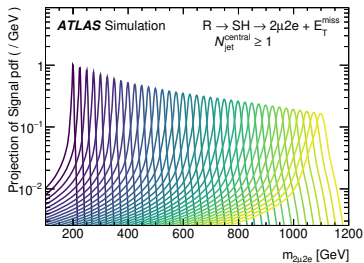
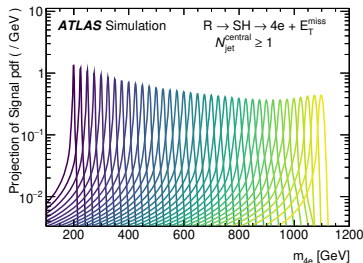
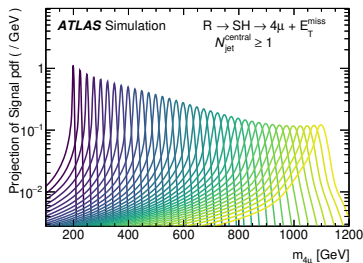
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The final signal shapes, interpolated from the polynomial fit parameters

At least one central jet category

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- ☐ A good fit quality is obtained in the whole mass points;
- ☐ The extraction of signal yields using the analytical function introduces about 1.5% bias;
- ☐ And can be included with the systematics uncertainty in the final fit.



Thank you!



Signal samples have already been produced, [JIRA](#), as follows:

- ☐ The mass of S is fixed to 160 GeV;
- ☐ The masses of R are 390 GeV, 450 GeV, 800 GeV and 1500 GeV:
 - $m_R = 390$ GeV: $m_H = 220$ GeV
 - $m_R = 450$ GeV: $m_H = 220$ GeV and 250 GeV
 - $m_R = 800$ GeV: $m_H = 220$ GeV, 300 GeV and 500 GeV
 - $m_R = 1500$ GeV: $m_H = 220$ GeV, 250 GeV and 1000 GeV
- ☐ Requested HIGG2D1 derivation with cache: 21.2.55 and p-tag: p3782. All jobs are finished see [here](#); and
- ☐ The mini-tree production is done using [HZZAnalRun2Code](#).

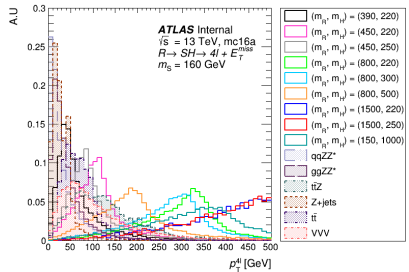
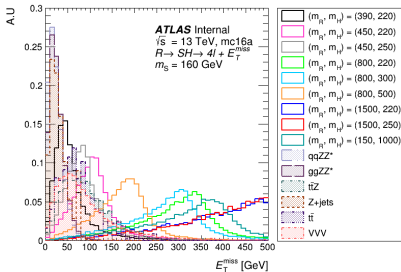
Background samples

- ☐ $qqZZ^*$, $ggZZ^*$, $t\bar{t}Z$, $Z + jets$, $t\bar{t}$ and VVV .

Additional slides

RSH-signal optimisation

35

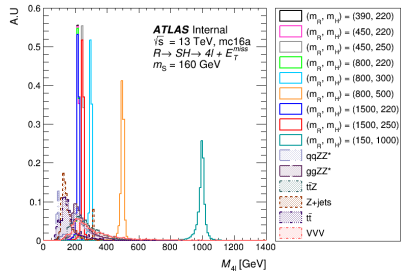
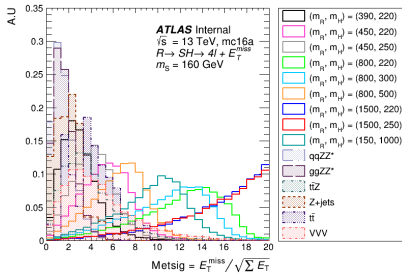


Optimise the $m_{4\ell}$ of the RSH-signal by doing 2D scan of $p_T^{4\ell}$ and E_T^{miss} , and select the cut that gives maximum significance.

Additional slides

RSH-signal optimisation

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Optimise the $m_{4\ell}$ of the RSH-signal by doing 2D scan of $p_T^{4\ell}$ and Metsig, and select the cut that gives maximum significance.

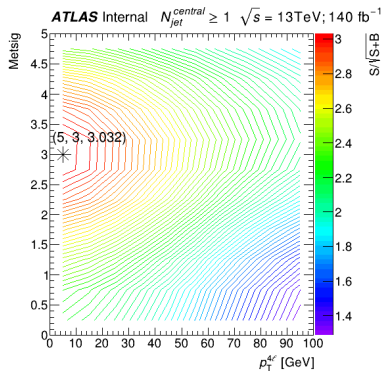
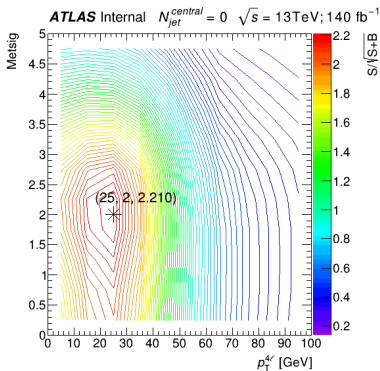
- Signal and background are mc16a, mc16d and mc16e combined;
- The signal cross section ($xsection \times BR$) is 1 fb^{-1} (set by hand);
- The significance is calculated using $S/\sqrt{S+B}$ and $S/\sqrt{B}$;
- S , and B are the signal and background event, respectively;
- Background events are normalised to cross section for the $m_{4\ell} > 200 \text{ GeV}$;
- Scaling background events by 20.3% uncertainty. It's calculated as follow:

The background scaled by a number extracted as follows: For instance, for $m_H = 220$, and $m_R = 390$: events in $m_{4\ell}(210 - 230) \text{ GeV}$ over the full range of $m_{4\ell}(> 200) \text{ GeV}$.

Additional slides

2D mapping of $p_T^{4\ell}$ and Metsig

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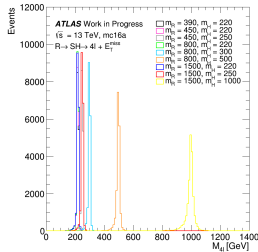
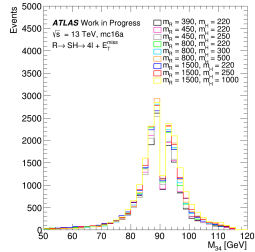
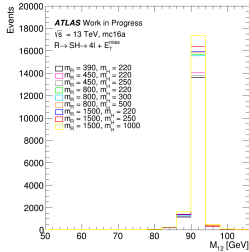


Event Selection	
QUADRUPLET SELECTION	- Require at least one quadruplet of leptons consisting of two pairs of same-flavour opposite-charge leptons fulfilling the following requirements: - p_T thresholds for three leading leptons in the quadruplet: 20, 15 and 10 GeV - At most 1 calo-tagged, stand-alone or silicon-associated muon per quadruplet - Leading di-lepton mass requirement: $50 < m_{12} < 106$ GeV - Sub-leading di-lepton mass requirement: $m_{\text{threshold}} < m_{34} < 115$ GeV - $\Delta R(\ell, \ell') > 0.10$ for all lepton pairs in the quadruplet - Remove quadruplet if alternative same-flavour opposite-charge di-lepton gives $m_{\ell\ell} < 5$ GeV - Keep all quadruplets passing the above selection
ISOLATION NEEDS UPDATING	- Contribution from the other leptons of the quadruplet is subtracted - Muon track isolation ($\Delta R = 0.30$): $\Sigma p_T/p_T < 0.15$ - Muon calorimeter isolation ($\Delta R = 0.20$): $\Sigma E_T/p_T < 0.30$ - Electron track isolation ($\Delta R = 0.20$): $\Sigma E_T/E_T < 0.15$ - Electron calorimeter isolation ($\Delta R = 0.20$): $\Sigma E_T/E_T < 0.20$
IMPACT PARAMETER SIGNIFICANCE	- Apply impact parameter significance cut to all leptons of the quadruplet - For electrons: $d_0/\sigma_{d_0} < 5$ - For muons: $d_0/\sigma_{d_0} < 3$
BEST QUADRUPLET	- If more than one quadruplet has been selected, choose the quadruplet with highest Higgs decay ME according to channel: $4\mu, 2e2\mu, 2\mu 2e$ and $4e$
VERTEX SELECTION	- Require a common vertex for the leptons: - $\chi^2/\text{ndof} < 5$ for 4μ and < 9 for others decay channels

Additional slides

Kinematic distributions for the signal

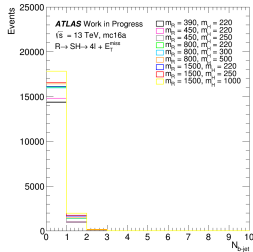
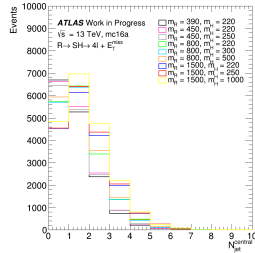
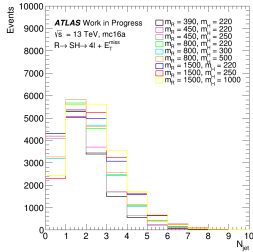
40



Additional slides

Kinematic distributions for the signal

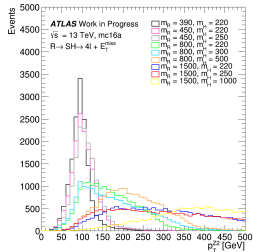
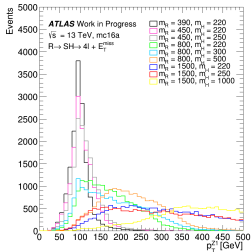
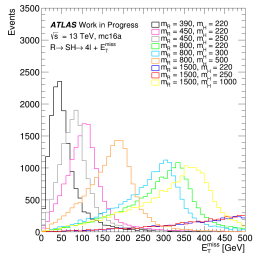
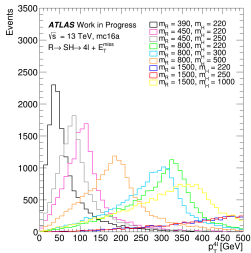
41



Additional slides

Kinematic distributions for the signal

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Additional slides

Kinematic distributions for signal & background

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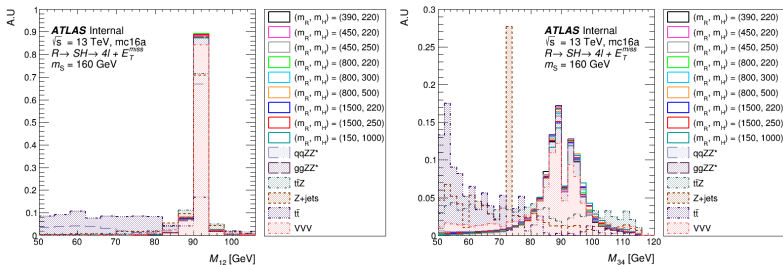


Figure: The invariant mass of the first (left) and the second (right) lepton pairs.

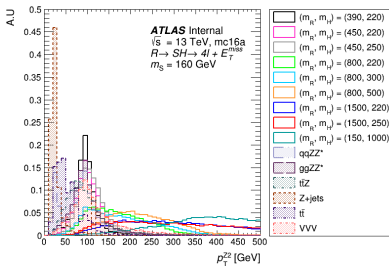
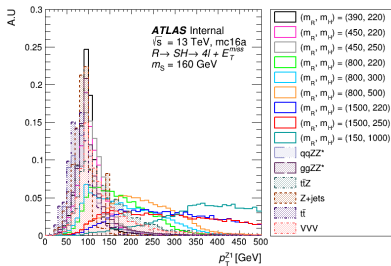
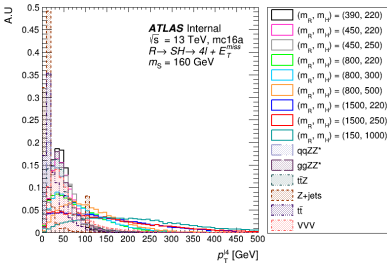
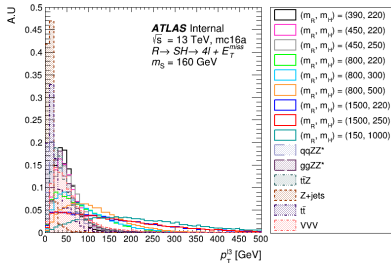
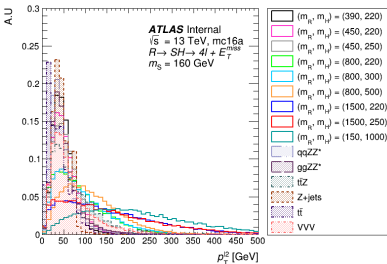
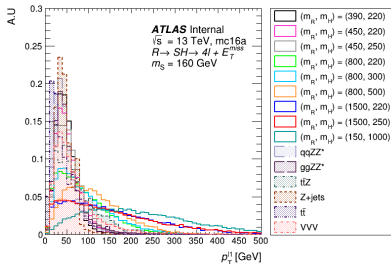


Figure: The invariant mass of the first (left) and the second (right) lepton pairs.

Additional slides

Kinematic distributions

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Additional slides

$p_T^{4\ell}$ and E_T^{miss} scan for zero central jet

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	$(m_H, m_H) = (390, 220)$	qqZZ*	ggZZ*	t $\bar{t}$ Z	Z + jets	t $\bar{t}$	VVV	s/ $\sqrt{s+b}$	s/ $\sqrt{b}$
4 ℓ	65.92 $\pm$ 0.29	2474.93 $\pm$ 7.43	345.02 $\pm$ 1.04	26.89 $\pm$ 0.61	2.59 $\pm$ 0.24	3.28 $\pm$ 0.56	13.74 $\pm$ 0.15	2.59	2.73
B-veto	61.32 $\pm$ 0.28	2358.82 $\pm$ 7.33	330.25 $\pm$ 1.02	4.45 $\pm$ 0.25	2.38 $\pm$ 0.23	1.94 $\pm$ 0.41	12.96 $\pm$ 0.15	2.48	2.61
$N_{\text{get}} = 0$	28.64 $\pm$ 0.19	1582.11 $\pm$ 6.15	208.34 $\pm$ 0.81	0.99 $\pm$ 0.10	1.82 $\pm$ 0.20	0.65 $\pm$ 0.23	7.22 $\pm$ 0.10	1.44	1.50
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 0.00$ GeV	28.64 $\pm$ 0.19	1582.11 $\pm$ 6.15	208.34 $\pm$ 0.81	0.99 $\pm$ 0.10	1.82 $\pm$ 0.20	0.65 $\pm$ 0.23	7.22 $\pm$ 0.10	1.44	1.50
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 10.00$ GeV	27.76 $\pm$ 0.19	1340.84 $\pm$ 5.70	184.65 $\pm$ 0.76	0.98 $\pm$ 0.09	1.67 $\pm$ 0.19	0.65 $\pm$ 0.23	7.11 $\pm$ 0.10	1.51	1.57
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 20.00$ GeV	24.99 $\pm$ 0.18	958.03 $\pm$ 4.79	137.07 $\pm$ 0.66	0.96 $\pm$ 0.09	1.35 $\pm$ 0.17	0.57 $\pm$ 0.22	6.80 $\pm$ 0.10	1.58	1.67
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 30.00$ GeV	20.74 $\pm$ 0.16	603.46 $\pm$ 3.81	89.74 $\pm$ 0.53	0.94 $\pm$ 0.09	1.01 $\pm$ 0.15	0.48 $\pm$ 0.20	6.38 $\pm$ 0.09	1.62	1.74
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 40.00$ GeV	15.31 $\pm$ 0.14	349.69 $\pm$ 2.81	53.37 $\pm$ 0.41	0.83 $\pm$ 0.09	0.64 $\pm$ 0.12	0.40 $\pm$ 0.18	5.86 $\pm$ 0.09	1.54	1.68
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 50.00$ GeV	10.20 $\pm$ 0.11	188.73 $\pm$ 1.98	29.02 $\pm$ 0.30	0.72 $\pm$ 0.08	0.37 $\pm$ 0.09	0.40 $\pm$ 0.18	5.29 $\pm$ 0.09	1.37	1.51
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 60.00$ GeV	6.30 $\pm$ 0.09	98.23 $\pm$ 1.43	14.80 $\pm$ 0.21	0.66 $\pm$ 0.08	0.21 $\pm$ 0.07	0.40 $\pm$ 0.18	4.69 $\pm$ 0.08	1.14	1.28
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 70.00$ GeV	3.76 $\pm$ 0.07	47.62 $\pm$ 0.97	7.24 $\pm$ 0.15	0.53 $\pm$ 0.07	0.16 $\pm$ 0.06	0.21 $\pm$ 0.13	4.10 $\pm$ 0.08	0.94	1.08
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 80.00$ GeV	2.12 $\pm$ 0.05	22.15 $\pm$ 0.64	3.49 $\pm$ 0.10	0.44 $\pm$ 0.07	0.10 $\pm$ 0.05	0.09 $\pm$ 0.09	3.58 $\pm$ 0.07	0.74	0.86
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 90.00$ GeV	1.20 $\pm$ 0.04	10.53 $\pm$ 0.43	1.64 $\pm$ 0.07	0.40 $\pm$ 0.06	0.10 $\pm$ 0.05	0.09 $\pm$ 0.09	3.11 $\pm$ 0.07	0.57	0.67
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.65 $\pm$ 0.03	4.90 $\pm$ 0.29	0.76 $\pm$ 0.05	0.32 $\pm$ 0.05	0.02 $\pm$ 0.02	0.09 $\pm$ 0.09	2.66 $\pm$ 0.06	0.42	0.49
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 0.00$ GeV	27.71 $\pm$ 0.19	1047.97 $\pm$ 5.52	177.23 $\pm$ 0.75	0.99 $\pm$ 0.10	1.55 $\pm$ 0.19	0.57 $\pm$ 0.22	7.10 $\pm$ 0.10	1.66	1.75
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 10.00$ GeV	26.92 $\pm$ 0.18	927.53 $\pm$ 5.17	160.03 $\pm$ 0.71	0.98 $\pm$ 0.09	1.44 $\pm$ 0.18	0.57 $\pm$ 0.22	7.01 $\pm$ 0.10	1.70	1.80
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 20.00$ GeV	24.38 $\pm$ 0.17	865.13 $\pm$ 4.35	119.53 $\pm$ 0.61	0.96 $\pm$ 0.09	1.19 $\pm$ 0.16	0.57 $\pm$ 0.22	6.73 $\pm$ 0.10	1.79	1.92
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 30.00$ GeV	20.31 $\pm$ 0.16	429.67 $\pm$ 3.48	79.14 $\pm$ 0.50	0.94 $\pm$ 0.09	0.87 $\pm$ 0.14	0.48 $\pm$ 0.20	6.33 $\pm$ 0.09	1.81	1.98
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 40.00$ GeV	15.00 $\pm$ 0.14	253.40 $\pm$ 2.57	47.59 $\pm$ 0.39	0.83 $\pm$ 0.09	0.57 $\pm$ 0.11	0.40 $\pm$ 0.18	5.83 $\pm$ 0.09	1.70	1.89
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 50.00$ GeV	10.01 $\pm$ 0.11	138.63 $\pm$ 1.80	26.04 $\pm$ 0.29	0.72 $\pm$ 0.08	0.35 $\pm$ 0.09	0.40 $\pm$ 0.18	5.26 $\pm$ 0.09	1.50	1.70
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 60.00$ GeV	6.18 $\pm$ 0.09	73.15 $\pm$ 1.31	13.38 $\pm$ 0.20	0.66 $\pm$ 0.08	0.21 $\pm$ 0.07	0.40 $\pm$ 0.18	4.67 $\pm$ 0.08	1.24	1.43
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 70.00$ GeV	3.71 $\pm$ 0.07	36.28 $\pm$ 0.89	6.57 $\pm$ 0.14	0.53 $\pm$ 0.07	0.16 $\pm$ 0.06	0.21 $\pm$ 0.13	4.09 $\pm$ 0.07	1.01	1.19
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 80.00$ GeV	2.09 $\pm$ 0.05	16.98 $\pm$ 0.59	3.18 $\pm$ 0.10	0.44 $\pm$ 0.07	0.10 $\pm$ 0.05	0.09 $\pm$ 0.09	3.57 $\pm$ 0.07	0.79	0.94
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 90.00$ GeV	1.19 $\pm$ 0.04	8.09 $\pm$ 0.39	1.49 $\pm$ 0.07	0.40 $\pm$ 0.06	0.10 $\pm$ 0.05	0.09 $\pm$ 0.09	3.10 $\pm$ 0.07	0.60	0.72
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.65 $\pm$ 0.03	3.85 $\pm$ 0.27	0.68 $\pm$ 0.05	0.32 $\pm$ 0.05	0.02 $\pm$ 0.02	0.09 $\pm$ 0.09	2.65 $\pm$ 0.06	0.44	0.52
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 0.00$ GeV	24.98 $\pm$ 0.18	560.98 $\pm$ 4.37	116.70 $\pm$ 0.61	0.97 $\pm$ 0.09	1.20 $\pm$ 0.17	0.57 $\pm$ 0.22	6.78 $\pm$ 0.10	1.95	2.11
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 10.00$ GeV	24.35 $\pm$ 0.17	508.27 $\pm$ 4.16	107.26 $\pm$ 0.58	0.96 $\pm$ 0.09	1.14 $\pm$ 0.16	0.57 $\pm$ 0.22	6.72 $\pm$ 0.10	1.98	2.16
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 20.00$ GeV	22.29 $\pm$ 0.17	386.27 $\pm$ 3.58	83.74 $\pm$ 0.51	0.94 $\pm$ 0.09	1.04 $\pm$ 0.15	0.57 $\pm$ 0.22	6.52 $\pm$ 0.09	2.04	2.26
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 30.00$ GeV	18.80 $\pm$ 0.15	255.52 $\pm$ 2.90	56.67 $\pm$ 0.42	0.92 $\pm$ 0.09	0.76 $\pm$ 0.13	0.48 $\pm$ 0.20	6.19 $\pm$ 0.09	2.05	2.33
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 40.00$ GeV	13.94 $\pm$ 0.13	155.77 $\pm$ 2.14	35.07 $\pm$ 0.33	0.81 $\pm$ 0.09	0.46 $\pm$ 0.10	0.40 $\pm$ 0.18	5.74 $\pm$ 0.09	1.89	2.20
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 50.00$ GeV	9.33 $\pm$ 0.11	87.44 $\pm$ 1.47	19.67 $\pm$ 0.25	0.71 $\pm$ 0.08	0.28 $\pm$ 0.08	0.40 $\pm$ 0.18	5.20 $\pm$ 0.08	1.64	1.94
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 60.00$ GeV	5.74 $\pm$ 0.08	47.35 $\pm$ 1.07	10.27 $\pm$ 0.18	0.65 $\pm$ 0.08	0.14 $\pm$ 0.05	0.40 $\pm$ 0.18	4.65 $\pm$ 0.08	1.33	1.60
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 70.00$ GeV	3.41 $\pm$ 0.06	24.19 $\pm$ 0.73	5.06 $\pm$ 0.13	0.52 $\pm$ 0.07	0.09 $\pm$ 0.04	0.21 $\pm$ 0.13	4.07 $\pm$ 0.07	1.06	1.29
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 80.00$ GeV	1.94 $\pm$ 0.05	11.82 $\pm$ 0.48	2.52 $\pm$ 0.09	0.43 $\pm$ 0.07	0.05 $\pm$ 0.03	0.09 $\pm$ 0.09	3.57 $\pm$ 0.07	0.81	1.00
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 90.00$ GeV	1.09 $\pm$ 0.04	5.49 $\pm$ 0.33	1.19 $\pm$ 0.06	0.39 $\pm$ 0.06	0.05 $\pm$ 0.03	0.09 $\pm$ 0.09	3.10 $\pm$ 0.07	0.61	0.76
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.59 $\pm$ 0.03	2.70 $\pm$ 0.22	0.53 $\pm$ 0.04	0.31 $\pm$ 0.05	0.02 $\pm$ 0.02	0.09 $\pm$ 0.09	2.65 $\pm$ 0.06	0.43	0.52
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 0.00$ GeV	20.20 $\pm$ 0.16	306.80 $\pm$ 2.95	69.12 $\pm$ 0.47	0.93 $\pm$ 0.09	0.87 $\pm$ 0.14	0.49 $\pm$ 0.20	6.30 $\pm$ 0.09	2.04	2.29
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 10.00$ GeV	19.77 $\pm$ 0.16	279.66 $\pm$ 2.82	64.10 $\pm$ 0.45	0.91 $\pm$ 0.09	0.83 $\pm$ 0.14	0.49 $\pm$ 0.20	6.26 $\pm$ 0.09	2.07	2.34
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 20.00$ GeV	18.32 $\pm$ 0.15	218.73 $\pm$ 2.50	51.98 $\pm$ 0.40	0.90 $\pm$ 0.09	0.81 $\pm$ 0.13	0.49 $\pm$ 0.20	6.13 $\pm$ 0.09	2.12	2.43
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 30.00$ GeV	15.85 $\pm$ 0.14	151.09 $\pm$ 2.02	36.70 $\pm$ 0.34	0.89 $\pm$ 0.09	0.61 $\pm$ 0.12	0.40 $\pm$ 0.18	5.91 $\pm$ 0.09	2.13	2.51
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 40.00$ GeV	12.00 $\pm$ 0.12	93.75 $\pm$ 1.40	23.23 $\pm$ 0.27	0.79 $\pm$ 0.09	0.39 $\pm$ 0.09	0.40 $\pm$ 0.18	5.54 $\pm$ 0.09	1.97	2.39
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 50.00$ GeV	8.07 $\pm$ 0.10	53.87 $\pm$ 1.05	13.61 $\pm$ 0.21	0.69 $\pm$ 0.08	0.26 $\pm$ 0.08	0.40 $\pm$ 0.18	5.08 $\pm$ 0.08	1.68	2.08

Additional slides

$p_T^{4\ell}$ and E_T^{miss} scan for zero central jet

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	$(m_R, m_A) = (390, 220)$	$qqZZ^*$	$ggZZ^*$	$t\bar{t}Z$	$Z + \text{jets}$	$t\bar{t}$	VVV	$s/\sqrt{s+b}$	$s/\sqrt{b}$
4ℓ	65.92±0.29	2474.93±7.43	345.02±1.04	26.89±0.61	2.59±0.24	3.28±0.56	13.74±0.15	2.59	2.73
B-veto	61.32±0.28	2358.82±7.33	330.25±1.02	4.45±0.25	2.38±0.23	1.94±0.41	12.96±0.15	2.48	2.61
$N_{\text{jet}} = 0$	28.64±0.19	1582.11±6.15	208.34±0.81	0.99±0.10	1.82±0.20	0.65±0.23	7.22±0.10	1.44	1.50
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 60.00$ GeV	5.01±0.08	30.02±0.75	7.28±0.15	0.64±0.08	0.14±0.05	0.40±0.18	4.58±0.08	1.35	1.69
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 70.00$ GeV	2.99±0.06	15.89±0.53	3.64±0.11	0.51±0.07	0.09±0.04	0.21±0.13	4.04±0.07	1.06	1.34
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 80.00$ GeV	1.70±0.05	8.17±0.36	1.85±0.08	0.43±0.07	0.05±0.03	0.09±0.09	3.55±0.07	0.80	1.01
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.97±0.03	4.02±0.24	0.91±0.05	0.39±0.06	0.05±0.03	0.09±0.09	3.08±0.07	0.59	0.74
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.52±0.03	1.87±0.17	0.41±0.04	0.31±0.05	0.02±0.02	0.09±0.09	2.64±0.06	0.41	0.50
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 0.00$ GeV	13.66±0.13	164.79±1.84	39.99±0.36	0.89±0.09	0.47±0.10	0.39±0.18	5.69±0.09	1.81	2.08
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 10.00$ GeV	13.41±0.13	151.54±1.74	37.26±0.34	0.87±0.09	0.47±0.10	0.39±0.18	5.67±0.09	1.84	2.12
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 20.00$ GeV	12.47±0.12	120.21±1.52	30.67±0.31	0.86±0.09	0.47±0.10	0.39±0.18	5.61±0.09	1.87	2.20
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 30.00$ GeV	10.96±0.12	86.25±1.24	22.39±0.27	0.84±0.09	0.38±0.09	0.30±0.16	5.47±0.09	1.87	2.26
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 40.00$ GeV	8.73±0.10	55.08±0.96	14.63±0.21	0.75±0.08	0.29±0.08	0.30±0.16	5.25±0.09	1.77	2.22
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 50.00$ GeV	6.03±0.09	32.14±0.72	8.86±0.17	0.66±0.08	0.16±0.06	0.30±0.16	4.87±0.08	1.53	1.95
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 60.00$ GeV	3.80±0.07	18.76±0.54	4.84±0.12	0.61±0.08	0.09±0.04	0.30±0.16	4.45±0.08	1.22	1.56
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 70.00$ GeV	2.37±0.05	10.59±0.39	2.47±0.09	0.49±0.07	0.07±0.04	0.21±0.13	3.97±0.07	0.97	1.25
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 80.00$ GeV	1.36±0.04	5.59±0.28	1.23±0.06	0.42±0.07	0.03±0.02	0.09±0.09	3.51±0.07	0.72	0.92
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.77±0.03	3.11±0.19	0.63±0.04	0.39±0.06	0.03±0.02	0.09±0.09	3.06±0.06	0.51	0.63
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.42±0.02	1.55±0.13	0.31±0.03	0.31±0.05	0.00±0.00	0.09±0.09	2.63±0.06	0.36	0.43
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 0.00$ GeV	7.39±0.10	92.53±1.23	23.15±0.27	0.82±0.09	0.34±0.09	0.30±0.16	5.14±0.08	1.30	1.48
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 10.00$ GeV	7.22±0.09	85.85±1.18	21.58±0.26	0.80±0.09	0.34±0.09	0.30±0.16	5.13±0.08	1.31	1.50
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 20.00$ GeV	6.69±0.09	69.21±1.01	17.86±0.24	0.79±0.08	0.34±0.09	0.30±0.16	5.10±0.08	1.32	1.54
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 30.00$ GeV	5.88±0.09	50.27±0.82	13.11±0.20	0.76±0.08	0.27±0.08	0.30±0.16	5.02±0.08	1.31	1.56
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 40.00$ GeV	4.79±0.08	32.77±0.66	8.72±0.17	0.68±0.08	0.22±0.07	0.30±0.16	4.88±0.08	1.26	1.54
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 50.00$ GeV	3.58±0.07	20.41±0.51	5.46±0.13	0.61±0.08	0.14±0.05	0.30±0.16	4.62±0.08	1.13	1.42
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 60.00$ GeV	2.35±0.05	12.13±0.39	3.10±0.10	0.58±0.08	0.09±0.04	0.30±0.16	4.29±0.08	0.92	1.15
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 70.00$ GeV	1.51±0.04	7.12±0.29	1.64±0.07	0.47±0.07	0.07±0.04	0.21±0.13	3.88±0.07	0.73	0.91
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 80.00$ GeV	0.89±0.03	3.84±0.21	0.82±0.05	0.42±0.06	0.03±0.02	0.09±0.09	3.44±0.07	0.55	0.67
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.53±0.03	2.24±0.14	0.42±0.04	0.38±0.06	0.03±0.02	0.09±0.09	3.03±0.06	0.39	0.47
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.31±0.02	1.14±0.10	0.21±0.02	0.29±0.05	0.00±0.00	0.09±0.09	2.62±0.06	0.29	0.33
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 0.00$ GeV	3.93±0.07	56.19±0.90	13.71±0.21	0.73±0.08	0.20±0.07	0.27±0.15	4.55±0.08	0.90	1.00
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 10.00$ GeV	3.84±0.07	52.00±0.86	12.85±0.20	0.72±0.08	0.20±0.07	0.27±0.15	4.54±0.08	0.90	1.01
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 20.00$ GeV	3.53±0.07	41.55±0.74	10.65±0.18	0.71±0.08	0.20±0.07	0.27±0.15	4.53±0.08	0.90	1.03
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 30.00$ GeV	3.06±0.06	30.67±0.59	7.91±0.16	0.69±0.08	0.18±0.06	0.27±0.15	4.49±0.08	0.88	1.02
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 40.00$ GeV	2.51±0.06	20.57±0.48	5.29±0.13	0.63±0.08	0.15±0.06	0.27±0.15	4.40±0.08	0.84	0.99
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 50.00$ GeV	1.98±0.05	12.93±0.37	3.44±0.10	0.58±0.08	0.09±0.04	0.27±0.15	4.23±0.08	0.78	0.94
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 60.00$ GeV	1.37±0.04	7.80±0.29	1.99±0.08	0.57±0.08	0.07±0.04	0.27±0.15	4.02±0.07	0.66	0.79
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 70.00$ GeV	0.93±0.03	4.75±0.21	1.11±0.06	0.46±0.07	0.07±0.04	0.17±0.12	3.69±0.07	0.54	0.65
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 80.00$ GeV	0.58±0.03	2.66±0.15	0.59±0.04	0.40±0.06	0.03±0.02	0.09±0.09	3.33±0.07	0.41	0.49
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.37±0.02	1.71±0.12	0.31±0.03	0.36±0.06	0.03±0.02	0.09±0.09	2.97±0.06	0.31	0.35
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.25±0.02	0.96±0.08	0.17±0.02	0.28±0.05	0.00±0.00	0.09±0.09	2.59±0.06	0.24	0.27

Additional slides

$p_T^{4\ell}$ and E_T^{miss} scan for one or more central jet

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	$(m_H, m_H) = (390, 220)$	qqZZ*	ggZZ*	$\bar{t}tZ$	Z + jets	$\bar{t}\bar{t}$	VVV	s/ $\sqrt{s+b}$	s/ $\sqrt{b}$
4 ℓ	65.92±0.29	2474.93±7.43	345.02±1.04	26.89±0.61	2.59±0.24	3.28±0.56	13.74±0.15	2.59	2.73
B-veto	61.32±0.28	2358.82±7.33	330.25±1.02	4.45±0.25	2.38±0.23	1.94±0.41	12.96±0.15	2.48	2.61
$N_{\text{jet}} \geq 1$	32.68±0.19	776.71±6.15	121.91±0.81	3.46±0.10	0.56±0.20	1.30±0.23	5.74±0.10	2.22	2.41
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 0.00$ GeV	32.68±0.19	776.71±6.15	121.91±0.81	3.46±0.10	0.56±0.20	1.30±0.23	5.74±0.10	2.22	2.41
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 10.00$ GeV	32.11±0.19	699.06±5.70	111.29±0.76	3.42±0.09	0.47±0.19	1.30±0.23	5.69±0.10	2.28	2.49
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 20.00$ GeV	30.40±0.18	534.26±4.79	87.26±0.66	3.32±0.09	0.38±0.17	1.30±0.22	5.52±0.10	2.41	2.68
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 30.00$ GeV	27.59±0.16	364.50±3.81	60.72±0.53	3.11±0.09	0.30±0.15	1.30±0.20	5.27±0.09	2.56	2.94
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 40.00$ GeV	24.23±0.14	225.64±2.81	38.50±0.41	2.97±0.09	0.16±0.12	1.22±0.18	4.94±0.09	2.71	3.25
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 50.00$ GeV	20.57±0.11	130.91±1.98	22.70±0.30	2.70±0.08	0.05±0.09	0.99±0.18	4.54±0.09	2.81	3.59
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 60.00$ GeV	17.11±0.09	73.40±1.43	12.71±0.21	2.49±0.08	0.01±0.07	0.99±0.18	4.09±0.08	2.85	3.92
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 70.00$ GeV	14.05±0.07	38.36±0.97	6.89±0.15	2.18±0.07	0.01±0.06	0.82±0.13	3.62±0.08	2.83	4.33
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 80.00$ GeV	11.32±0.05	20.64±0.64	3.59±0.10	1.94±0.07	0.01±0.05	0.65±0.09	3.27±0.07	2.71	4.58
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 90.00$ GeV	9.08±0.04	10.47±0.43	1.80±0.07	1.73±0.06	0.03±0.05	0.57±0.09	2.93±0.07	2.56	4.82
$p_T^{4\ell} > 0.0$ & $E_T^{\text{miss}} > 100.00$ GeV	7.40±0.03	5.45±0.29	0.92±0.05	1.46±0.05	0.03±0.02	0.48±0.09	2.62±0.06	2.39	4.96
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 0.00$ GeV	32.17±0.19	756.97±5.52	120.08±0.75	3.48±0.10	0.56±0.19	1.30±0.22	5.69±0.10	2.21	2.40
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 10.00$ GeV	31.60±0.18	680.91±5.17	109.59±0.71	3.43±0.09	0.47±0.18	1.30±0.22	5.65±0.10	2.27	2.48
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 20.00$ GeV	29.91±0.17	519.30±4.35	85.85±0.61	3.33±0.09	0.38±0.16	1.30±0.22	5.48±0.10	2.40	2.68
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 30.00$ GeV	27.14±0.16	353.42±3.48	59.68±0.50	3.13±0.09	0.30±0.14	1.30±0.20	5.23±0.09	2.55	2.93
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 40.00$ GeV	23.83±0.14	218.62±2.57	37.84±0.39	2.98±0.09	0.16±0.11	1.22±0.18	4.91±0.09	2.70	3.24
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 50.00$ GeV	20.28±0.11	126.73±1.80	22.31±0.29	2.71±0.08	0.05±0.09	0.99±0.18	4.51±0.09	2.81	3.59
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 60.00$ GeV	16.89±0.09	70.99±1.31	12.50±0.20	2.49±0.08	0.01±0.07	0.99±0.18	4.07±0.08	2.84	3.93
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 70.00$ GeV	13.89±0.07	37.21±0.89	6.78±0.14	2.19±0.07	0.01±0.06	0.82±0.13	3.61±0.07	2.83	4.33
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 80.00$ GeV	11.23±0.05	20.06±0.59	3.53±0.10	1.96±0.07	0.01±0.05	0.65±0.09	3.26±0.07	2.71	4.59
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 90.00$ GeV	9.04±0.04	10.21±0.39	1.77±0.07	1.74±0.06	0.03±0.05	0.57±0.09	2.92±0.07	2.55	4.83
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 100.00$ GeV	7.36±0.03	5.33±0.27	0.91±0.05	1.47±0.05	0.03±0.02	0.48±0.09	2.62±0.06	2.38	4.96
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 0.00$ GeV	30.64±0.18	717.49±4.37	113.74±0.61	3.44±0.09	0.56±0.17	1.30±0.22	5.56±0.10	2.16	2.34
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 10.00$ GeV	30.11±0.17	644.57±4.16	103.66±0.58	3.39±0.09	0.47±0.16	1.30±0.22	5.52±0.10	2.22	2.43
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 20.00$ GeV	28.46±0.17	490.94±3.58	81.12±0.51	3.30±0.09	0.38±0.15	1.30±0.22	5.36±0.09	2.35	2.62
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 30.00$ GeV	25.83±0.15	333.22±2.90	56.28±0.42	3.10±0.09	0.30±0.13	1.30±0.20	5.12±0.09	2.50	2.87
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 40.00$ GeV	22.70±0.13	205.37±2.13	35.67±0.33	2.95±0.09	0.16±0.10	1.22±0.18	4.82±0.09	2.65	3.18
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 50.00$ GeV	19.38±0.11	118.81±1.47	21.06±0.25	2.70±0.08	0.05±0.08	0.99±0.18	4.44±0.08	2.76	3.54
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 60.00$ GeV	16.22±0.08	66.49±1.07	11.79±0.18	2.48±0.08	0.01±0.05	0.99±0.18	4.02±0.08	2.80	3.89
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 70.00$ GeV	13.41±0.06	35.08±0.73	6.41±0.13	2.20±0.07	0.01±0.04	0.82±0.13	3.57±0.07	2.79	4.29
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 80.00$ GeV	10.93±0.05	18.87±0.48	3.33±0.09	1.97±0.07	0.01±0.03	0.65±0.09	3.22±0.07	2.68	4.58
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 90.00$ GeV	8.85±0.04	9.70±0.33	1.64±0.06	1.76±0.06	0.03±0.03	0.57±0.09	2.89±0.07	2.53	4.82
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 100.00$ GeV	7.25±0.03	5.21±0.22	0.85±0.04	1.48±0.05	0.03±0.02	0.48±0.09	2.60±0.06	2.36	4.93
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 0.00$ GeV	28.32±0.16	660.79±2.95	102.60±0.47	3.36±0.09	0.52±0.14	1.21±0.20	5.38±0.09	2.08	2.26
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 10.00$ GeV	27.81±0.16	593.58±2.82	93.47±0.45	3.31±0.09	0.45±0.14	1.21±0.20	5.34±0.09	2.14	2.34
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 20.00$ GeV	26.26±0.15	451.85±2.50	73.18±0.40	3.22±0.09	0.38±0.13	1.21±0.20	5.19±0.09	2.26	2.52
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 30.00$ GeV	23.81±0.14	306.11±2.02	50.74±0.34	3.02±0.09	0.30±0.12	1.21±0.18	4.96±0.09	2.40	2.76
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 40.00$ GeV	20.91±0.12	188.86±1.40	32.19±0.27	2.88±0.09	0.16±0.09	1.13±0.18	4.68±0.09	2.54	3.06
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 50.00$ GeV	17.93±0.10	109.05±1.05	19.10±0.21	2.63±0.08	0.05±0.08	0.99±0.18	4.32±0.08	2.66	3.41

Additional slides

$p_T^{4\ell}$ and E_T^{miss} scan for one or more central jet

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	$(m_H, m_H) = (390, 220)$	qqZZ*	ggZZ*	$t\bar{t}Z$	Z + jets	$t\bar{t}$	VVV	$s/\sqrt{s+b}$	$s/\sqrt{b}$
4 ℓ	65.92±0.29	2474.93±7.43	345.02±1.04	26.89±0.61	2.59±0.24	3.28±0.56	13.74±0.15	2.59	2.73
B-veto	61.32±0.28	2358.82±7.33	330.25±1.02	4.45±0.25	2.38±0.23	1.94±0.41	12.96±0.15	2.48	2.61
$N_{\text{jet}} \geq 1$	32.68±0.19	776.71±6.15	121.91±0.81	3.46±0.10	0.56±0.20	1.30±0.23	5.74±0.10	2.22	2.41
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 60.00$ GeV	15.11±0.08	60.92±0.75	10.68±0.15	2.42±0.08	0.01±0.05	0.99±0.18	3.93±0.08	2.71	3.78
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 70.00$ GeV	12.62±0.06	32.26±0.53	5.77±0.11	2.16±0.07	0.01±0.04	0.82±0.13	3.49±0.07	2.71	4.20
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 80.00$ GeV	10.40±0.05	17.49±0.36	3.03±0.08	1.94±0.07	0.01±0.03	0.65±0.09	3.16±0.07	2.62	4.50
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 90.00$ GeV	8.54±0.03	9.04±0.24	1.51±0.05	1.73±0.06	0.03±0.03	0.57±0.09	2.84±0.07	2.49	4.78
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 100.00$ GeV	7.05±0.03	4.81±0.17	0.79±0.04	1.45±0.05	0.03±0.02	0.48±0.09	2.56±0.06	2.34	4.92
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 0.00$ GeV	25.48±0.13	582.02±1.84	88.65±0.36	3.26±0.09	0.45±0.10	1.21±0.18	5.10±0.09	1.99	2.17
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 10.00$ GeV	25.02±0.13	524.47±1.74	80.88±0.34	3.22±0.09	0.38±0.10	1.21±0.18	5.07±0.09	2.04	2.24
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 20.00$ GeV	23.63±0.12	402.38±1.52	63.60±0.31	3.12±0.09	0.33±0.10	1.21±0.18	4.93±0.09	2.16	2.40
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 30.00$ GeV	21.47±0.12	272.84±1.24	44.13±0.27	2.95±0.09	0.30±0.09	1.21±0.16	4.72±0.09	2.29	2.64
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 40.00$ GeV	18.90±0.10	169.68±0.96	28.03±0.21	2.80±0.08	0.18±0.08	1.13±0.16	4.47±0.09	2.42	2.92
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 50.00$ GeV	16.32±0.09	97.95±0.72	16.69±0.17	2.57±0.08	0.08±0.06	0.99±0.16	4.14±0.08	2.54	3.27
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 60.00$ GeV	13.88±0.07	54.73±0.54	9.37±0.12	2.37±0.08	0.03±0.04	0.99±0.16	3.78±0.08	2.61	3.65
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 70.00$ GeV	11.74±0.05	29.10±0.39	5.08±0.09	2.11±0.07	0.03±0.04	0.82±0.13	3.37±0.07	2.63	4.09
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 80.00$ GeV	9.78±0.04	15.88±0.28	2.70±0.06	1.91±0.07	0.03±0.02	0.65±0.09	3.07±0.07	2.55	4.41
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 90.00$ GeV	8.16±0.03	8.33±0.19	1.38±0.04	1.69±0.06	0.03±0.02	0.57±0.09	2.77±0.06	2.44	4.71
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 100.00$ GeV	6.85±0.02	4.46±0.13	0.74±0.03	1.43±0.05	0.03±0.00	0.48±0.09	2.51±0.06	2.31	4.89
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 0.00$ GeV	22.44±0.10	497.49±1.23	73.83±0.27	3.11±0.09	0.37±0.09	1.13±0.16	4.85±0.08	1.89	2.07
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 10.00$ GeV	22.01±0.09	449.69±1.18	67.65±0.26	3.08±0.09	0.30±0.09	1.13±0.16	4.81±0.08	1.94	2.13
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 20.00$ GeV	20.86±0.09	346.71±1.01	53.45±0.24	3.00±0.08	0.25±0.09	1.13±0.16	4.70±0.08	2.05	2.29
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 30.00$ GeV	18.98±0.09	237.17±0.82	37.25±0.20	2.83±0.08	0.23±0.08	1.13±0.16	4.51±0.08	2.17	2.50
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 40.00$ GeV	16.82±0.08	148.50±0.66	23.83±0.17	2.71±0.08	0.14±0.07	1.05±0.16	4.28±0.08	2.30	2.78
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 50.00$ GeV	14.67±0.07	86.52±0.51	14.30±0.13	2.48±0.08	0.08±0.05	0.91±0.16	3.98±0.08	2.42	3.13
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 60.00$ GeV	12.61±0.05	48.36±0.39	8.05±0.10	2.30±0.08	0.03±0.04	0.91±0.16	3.65±0.08	2.50	3.52
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 70.00$ GeV	10.81±0.04	26.04±0.29	4.39±0.07	2.03±0.07	0.03±0.04	0.74±0.13	3.27±0.07	2.53	3.97
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 80.00$ GeV	9.13±0.03	14.32±0.21	2.33±0.05	1.84±0.06	0.03±0.02	0.57±0.09	2.98±0.07	2.48	4.32
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 90.00$ GeV	7.72±0.03	7.61±0.14	1.24±0.04	1.63±0.06	0.03±0.02	0.57±0.09	2.70±0.06	2.38	4.62
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 100.00$ GeV	6.56±0.02	4.20±0.10	0.67±0.02	1.37±0.05	0.03±0.00	0.48±0.09	2.46±0.06	2.26	4.80
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 0.00$ GeV	19.33±0.07	422.91±0.90	60.23±0.21	2.93±0.08	0.31±0.07	1.04±0.15	4.59±0.08	1.77	1.93
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 10.00$ GeV	18.98±0.07	383.80±0.86	55.48±0.20	2.90±0.08	0.28±0.07	1.04±0.15	4.56±0.08	1.81	1.99
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 20.00$ GeV	18.06±0.07	298.23±0.74	44.24±0.18	2.83±0.08	0.23±0.07	1.04±0.15	4.46±0.08	1.91	2.14
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 30.00$ GeV	16.55±0.06	205.70±0.59	31.03±0.16	2.67±0.08	0.21±0.06	1.04±0.15	4.29±0.08	2.03	2.35
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 40.00$ GeV	14.80±0.06	129.99±0.48	20.04±0.13	2.54±0.08	0.14±0.06	0.96±0.15	4.08±0.08	2.16	2.62
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 50.00$ GeV	13.06±0.05	76.97±0.37	12.06±0.10	2.32±0.08	0.08±0.04	0.82±0.15	3.81±0.08	2.29	2.96
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 60.00$ GeV	11.36±0.04	43.64±0.29	6.80±0.08	2.16±0.08	0.03±0.04	0.82±0.15	3.51±0.07	2.37	3.34
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 70.00$ GeV	9.92±0.03	24.06±0.21	3.76±0.06	1.90±0.07	0.03±0.04	0.65±0.12	3.15±0.07	2.42	3.80
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 80.00$ GeV	8.49±0.03	12.99±0.15	1.99±0.04	1.70±0.06	0.03±0.02	0.57±0.09	2.88±0.07	2.39	4.20
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 90.00$ GeV	7.27±0.02	6.96±0.12	1.05±0.03	1.51±0.06	0.03±0.02	0.57±0.09	2.61±0.06	2.32	4.53
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 100.00$ GeV	6.24±0.02	3.91±0.08	0.59±0.02	1.28±0.05	0.03±0.00	0.48±0.09	2.39±0.06	2.21	4.70

Additional slides

$p_T^{4\ell}$ and E_T^{miss} scan for zero jet

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	$(m_H, m_{H'}) = (390, 220)$	qqZZ*	ggZZ*	$\bar{t}tZ$	Z + jets	$\bar{t}\bar{t}$	VVV	$s/\sqrt{s+b}$	$s/\sqrt{b}$
4 ℓ	65.92±0.29	2474.93±7.43	345.02±1.04	26.89±0.61	2.59±0.24	3.28±0.56	13.74±0.15	2.59	2.73
B-veto	61.32±0.28	2358.82±7.33	330.25±1.02	4.45±0.25	2.38±0.23	1.94±0.41	12.96±0.15	2.48	2.61
$N_{\text{jet}} = 0$	22.44±0.17	1434.33±5.84	176.34±0.75	0.65±0.08	1.52±0.19	0.61±0.23	6.47±0.09	1.20	1.24
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 0.00$ GeV	22.44±0.17	1434.33±5.84	176.34±0.75	0.65±0.08	1.52±0.19	0.61±0.23	6.47±0.09	1.20	1.24
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 10.00$ GeV	21.73±0.16	1204.91±5.39	155.38±0.70	0.65±0.08	1.37±0.17	0.61±0.23	6.36±0.09	1.26	1.30
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 20.00$ GeV	19.51±0.16	847.15±4.55	114.02±0.60	0.65±0.08	1.05±0.15	0.53±0.21	6.08±0.09	1.33	1.39
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 30.00$ GeV	16.02±0.14	522.45±3.58	73.28±0.48	0.64±0.08	0.75±0.13	0.44±0.20	5.68±0.09	1.36	1.45
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 40.00$ GeV	11.48±0.12	295.20±2.62	42.67±0.37	0.54±0.07	0.46±0.10	0.36±0.18	5.23±0.08	1.27	1.37
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 50.00$ GeV	7.21±0.09	154.78±1.81	22.52±0.27	0.48±0.07	0.23±0.07	0.36±0.18	4.71±0.08	1.08	1.18
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 60.00$ GeV	4.15±0.07	77.93±1.28	11.26±0.19	0.42±0.07	0.12±0.05	0.36±0.18	4.18±0.08	0.86	0.95
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 70.00$ GeV	2.21±0.05	36.36±0.85	5.33±0.13	0.34±0.06	0.07±0.04	0.17±0.12	3.64±0.07	0.65	0.73
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 80.00$ GeV	1.10±0.04	16.33±0.56	2.55±0.09	0.30±0.06	0.05±0.03	0.09±0.09	3.17±0.07	0.46	0.52
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.58±0.03	7.61±0.37	1.19±0.06	0.27±0.05	0.05±0.03	0.09±0.09	2.74±0.06	0.33	0.37
$p_T^{4\ell} > 0.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.27±0.02	3.57±0.25	0.55±0.04	0.20±0.05	0.00±0.00	0.09±0.09	2.34±0.06	0.21	0.23
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 0.00$ GeV	21.67±0.16	923.94±5.20	146.79±0.68	0.66±0.08	1.26±0.17	0.53±0.21	6.36±0.09	1.40	1.46
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 10.00$ GeV	21.05±0.16	814.40±4.86	132.27±0.65	0.66±0.08	1.15±0.16	0.53±0.21	6.28±0.09	1.44	1.51
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 20.00$ GeV	19.04±0.15	574.75±4.11	97.82±0.55	0.65±0.08	0.89±0.14	0.53±0.21	6.02±0.09	1.52	1.62
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 30.00$ GeV	15.71±0.14	365.01±3.27	63.76±0.45	0.65±0.08	0.62±0.12	0.44±0.20	5.65±0.09	1.54	1.67
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 40.00$ GeV	11.27±0.12	210.28±2.39	37.65±0.34	0.55±0.07	0.39±0.09	0.36±0.18	5.21±0.08	1.42	1.57
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 50.00$ GeV	7.09±0.09	111.80±1.64	20.05±0.25	0.48±0.07	0.21±0.07	0.36±0.18	4.69±0.08	1.20	1.34
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 60.00$ GeV	4.08±0.07	57.28±1.17	10.12±0.18	0.42±0.07	0.12±0.05	0.36±0.18	4.17±0.08	0.94	1.06
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 70.00$ GeV	2.18±0.05	27.58±0.78	4.82±0.12	0.34±0.06	0.07±0.04	0.17±0.12	3.64±0.07	0.70	0.80
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 80.00$ GeV	1.08±0.04	12.43±0.51	2.33±0.08	0.30±0.06	0.05±0.03	0.09±0.09	3.17±0.07	0.49	0.56
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.57±0.03	5.80±0.33	1.08±0.06	0.27±0.05	0.05±0.03	0.09±0.09	2.74±0.06	0.35	0.40
$p_T^{4\ell} > 10.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.27±0.02	2.80±0.23	0.49±0.04	0.20±0.05	0.00±0.00	0.09±0.09	2.34±0.06	0.22	0.25
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 0.00$ GeV	19.42±0.16	462.06±4.02	90.05±0.53	0.65±0.08	0.92±0.14	0.53±0.21	6.06±0.09	1.68	1.82
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 10.00$ GeV	18.95±0.15	419.23±3.84	83.09±0.51	0.65±0.08	0.86±0.14	0.53±0.21	6.00±0.09	1.71	1.86
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 20.00$ GeV	17.41±0.15	316.75±3.35	65.02±0.45	0.64±0.08	0.77±0.13	0.53±0.21	5.83±0.09	1.77	1.96
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 30.00$ GeV	14.61±0.13	207.08±2.71	43.62±0.37	0.63±0.08	0.53±0.11	0.44±0.20	5.53±0.09	1.79	2.02
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 40.00$ GeV	10.57±0.11	124.27±1.99	26.80±0.29	0.53±0.07	0.30±0.08	0.36±0.18	5.13±0.08	1.62	1.87
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 50.00$ GeV	6.70±0.09	68.25±1.33	14.71±0.21	0.47±0.07	0.17±0.06	0.36±0.18	4.65±0.08	1.35	1.58
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 60.00$ GeV	3.87±0.07	35.87±0.95	7.60±0.15	0.41±0.07	0.08±0.04	0.36±0.18	4.16±0.07	1.05	1.23
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 70.00$ GeV	2.06±0.05	18.03±0.63	3.66±0.11	0.33±0.06	0.03±0.02	0.17±0.12	3.63±0.07	0.76	0.90
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 80.00$ GeV	1.03±0.04	8.54±0.41	1.82±0.08	0.29±0.06	0.03±0.02	0.09±0.09	3.17±0.07	0.53	0.61
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.54±0.03	3.94±0.27	0.87±0.05	0.26±0.05	0.03±0.02	0.09±0.09	2.74±0.06	0.37	0.43
$p_T^{4\ell} > 20.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.25±0.02	2.07±0.18	0.39±0.03	0.19±0.04	0.00±0.00	0.09±0.09	2.34±0.06	0.22	0.25
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 0.00$ GeV	15.35±0.14	228.23±2.62	47.47±0.39	0.61±0.08	0.64±0.12	0.45±0.20	5.61±0.09	1.80	2.03
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 10.00$ GeV	15.07±0.14	209.57±2.52	44.52±0.37	0.61±0.08	0.60±0.11	0.45±0.20	5.57±0.09	1.83	2.07
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 20.00$ GeV	14.08±0.13	165.15±2.26	36.86±0.34	0.61±0.08	0.58±0.11	0.45±0.20	5.47±0.09	1.87	2.16
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 30.00$ GeV	12.25±0.12	114.20±1.82	26.27±0.29	0.61±0.08	0.41±0.09	0.36±0.18	5.27±0.08	1.89	2.24
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 40.00$ GeV	9.11±0.11	70.12±1.24	16.77±0.23	0.52±0.07	0.25±0.07	0.36±0.18	4.96±0.08	1.72	2.10

Additional slides

$p_T^{4\ell}$ and E_T^{miss} scan for zero jet

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	$(m_B, m_H) = (390, 220)$	$qqZZ^*$	$ggZZ^*$	$t\bar{t}Z$	$Z + \text{jets}$	$t\bar{t}$	VVV	$s/\sqrt{s+b}$	$s/\sqrt{b}$
4ℓ	65.92±0.29	2474.93±7.43	345.02±1.04	26.89±0.61	2.59±0.24	3.28±0.56	13.74±0.15	2.59	2.73
B-veto	61.32±0.28	2358.82±7.33	330.25±1.02	4.45±0.25	2.38±0.23	1.94±0.41	12.96±0.15	2.48	2.61
$N_{\text{jet}} = 0$	22.44±0.17	1434.33±5.84	176.34±0.75	0.65±0.08	1.52±0.19	0.61±0.23	6.47±0.09	1.20	1.24
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 50.00$ GeV	5.82±0.08	39.86±0.92	9.73±0.17	0.45±0.07	0.17±0.06	0.36±0.18	4.54±0.08	1.41	1.74
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 60.00$ GeV	3.40±0.06	21.64±0.65	5.19±0.13	0.41±0.07	0.07±0.04	0.36±0.18	4.09±0.07	1.08	1.34
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 70.00$ GeV	1.83±0.05	11.32±0.45	2.55±0.09	0.33±0.06	0.03±0.02	0.17±0.12	3.60±0.07	0.78	0.96
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 80.00$ GeV	0.93±0.03	5.63±0.29	1.32±0.06	0.29±0.06	0.03±0.02	0.09±0.09	3.15±0.07	0.53	0.64
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.48±0.02	2.72±0.19	0.66±0.05	0.26±0.05	0.03±0.02	0.09±0.09	2.73±0.06	0.36	0.42
$p_T^{4\ell} > 30.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.22±0.02	1.34±0.13	0.29±0.03	0.19±0.04	0.00±0.00	0.09±0.09	2.34±0.06	0.21	0.24
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 0.00$ GeV	9.53±0.11	103.93±1.43	23.19±0.27	0.59±0.08	0.36±0.09	0.35±0.17	5.05±0.08	1.57	1.83
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 10.00$ GeV	9.41±0.11	97.12±1.39	22.01±0.26	0.59±0.07	0.36±0.09	0.35±0.17	5.03±0.08	1.59	1.86
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 20.00$ GeV	8.89±0.11	78.73±1.25	18.78±0.24	0.59±0.07	0.36±0.09	0.35±0.17	4.98±0.08	1.62	1.94
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 30.00$ GeV	7.94±0.10	57.66±1.03	14.22±0.21	0.58±0.07	0.29±0.08	0.27±0.15	4.86±0.08	1.63	2.00
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 40.00$ GeV	6.33±0.09	36.93±0.79	9.63±0.17	0.50±0.07	0.20±0.07	0.27±0.15	4.70±0.08	1.54	1.94
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 50.00$ GeV	4.15±0.07	21.51±0.59	5.86±0.14	0.44±0.07	0.12±0.05	0.27±0.15	4.36±0.08	1.27	1.61
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 60.00$ GeV	2.47±0.06	12.41±0.44	3.24±0.10	0.39±0.07	0.05±0.03	0.27±0.15	3.99±0.07	0.96	1.21
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 70.00$ GeV	1.40±0.04	6.98±0.31	1.63±0.07	0.32±0.06	0.03±0.02	0.17±0.12	3.54±0.07	0.70	0.87
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 80.00$ GeV	0.71±0.03	3.72±0.21	0.83±0.05	0.28±0.06	0.03±0.02	0.09±0.09	3.12±0.06	0.46	0.55
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.36±0.02	2.16±0.15	0.44±0.04	0.25±0.05	0.03±0.02	0.09±0.09	2.72±0.06	0.29	0.33
$p_T^{4\ell} > 40.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.16±0.01	1.15±0.11	0.22±0.03	0.18±0.04	0.00±0.00	0.09±0.09	2.33±0.06	0.16	0.17
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 0.00$ GeV	4.18±0.07	48.07±0.82	10.81±0.18	0.52±0.07	0.25±0.08	0.27±0.15	4.56±0.08	1.01	1.16
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 10.00$ GeV	4.12±0.07	45.54±0.79	10.33±0.18	0.51±0.07	0.25±0.08	0.27±0.15	4.55±0.08	1.01	1.17
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 20.00$ GeV	3.92±0.07	38.48±0.72	9.05±0.17	0.51±0.07	0.25±0.08	0.27±0.15	4.53±0.08	1.02	1.19
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 30.00$ GeV	3.54±0.07	29.31±0.62	7.05±0.15	0.49±0.07	0.20±0.07	0.27±0.15	4.46±0.08	1.02	1.22
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 40.00$ GeV	2.93±0.06	19.59±0.50	5.06±0.13	0.42±0.07	0.16±0.06	0.27±0.15	4.36±0.08	0.98	1.19
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 50.00$ GeV	2.11±0.05	12.52±0.39	3.23±0.10	0.38±0.06	0.09±0.05	0.27±0.15	4.14±0.07	0.84	1.03
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 60.00$ GeV	1.29±0.04	7.42±0.29	1.92±0.08	0.35±0.06	0.05±0.03	0.27±0.15	3.85±0.07	0.64	0.77
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 70.00$ GeV	0.73±0.03	4.49±0.21	1.02±0.06	0.30±0.06	0.03±0.02	0.17±0.12	3.47±0.07	0.45	0.53
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 80.00$ GeV	0.38±0.02	2.49±0.14	0.52±0.04	0.27±0.05	0.03±0.02	0.09±0.09	3.07±0.06	0.29	0.33
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.20±0.02	1.57±0.11	0.28±0.03	0.24±0.05	0.03±0.02	0.09±0.09	2.70±0.06	0.18	0.20
$p_T^{4\ell} > 50.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.09±0.01	0.87±0.08	0.14±0.02	0.17±0.04	0.00±0.00	0.09±0.09	2.32±0.06	0.10	0.10
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 0.00$ GeV	1.55±0.04	23.90±0.53	4.96±0.12	0.46±0.07	0.13±0.05	0.27±0.15	4.02±0.07	0.53	0.59
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 10.00$ GeV	1.52±0.04	22.61±0.51	4.81±0.12	0.46±0.07	0.13±0.05	0.27±0.15	4.01±0.07	0.54	0.59
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 20.00$ GeV	1.46±0.04	19.14±0.47	4.30±0.12	0.45±0.07	0.13±0.05	0.27±0.15	4.00±0.07	0.54	0.61
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 30.00$ GeV	1.33±0.04	15.06±0.40	3.47±0.10	0.45±0.07	0.13±0.05	0.27±0.15	3.97±0.07	0.54	0.61
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 40.00$ GeV	1.13±0.04	10.70±0.33	2.59±0.09	0.39±0.06	0.11±0.05	0.27±0.15	3.91±0.07	0.52	0.59
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 50.00$ GeV	0.86±0.03	7.02±0.26	1.76±0.07	0.36±0.06	0.05±0.03	0.27±0.15	3.78±0.07	0.46	0.53
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 60.00$ GeV	0.56±0.03	4.36±0.21	1.10±0.06	0.35±0.06	0.03±0.02	0.27±0.15	3.60±0.07	0.35	0.40
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 70.00$ GeV	0.33±0.02	2.84±0.15	0.66±0.05	0.29±0.06	0.03±0.02	0.17±0.12	3.30±0.07	0.24	0.27
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 80.00$ GeV	0.17±0.01	1.75±0.11	0.37±0.03	0.27±0.05	0.03±0.02	0.09±0.09	2.97±0.06	0.15	0.16
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 90.00$ GeV	0.09±0.01	1.18±0.09	0.21±0.03	0.23±0.05	0.03±0.02	0.09±0.09	2.64±0.06	0.09	0.09
$p_T^{4\ell} > 60.00$ & $E_T^{\text{miss}} > 100.00$ GeV	0.05±0.01	0.73±0.07	0.11±0.02	0.17±0.04	0.00±0.00	0.09±0.09	2.30±0.06	0.06	0.06